



SUPERPAVE ASPHALTIC CONCRETE PAVEMENT MSP-95-03Z

1.0 Description. This work shall consist of providing a Superpave bituminous mixture (Type SP125xy, SP125xyLP, SP125xySM, SP190xy, or SP250xy) to be placed in one or more courses on a prepared base or underlying course in conformance with the lines, grades, thicknesses, and typical cross sections shown on the plans, or established by the engineer.

1.1 Superpave (SP) bituminous mixtures are dense graded bituminous mixtures compacted in the Laboratory with a Superpave Gyratory Compactor. The gyratory compactor shall be one as approved by the North Central Superpave Center at Purdue University in West Lafayette, Indiana. An approved list is maintained by Materials Engineering. All other equipment shall be capable of performing tests in accordance with the approved test methods. The bituminous mixtures shall meet all the requirements for asphaltic concrete in Sec 403, except as modified herein. Delete Sec 403.1 through 403.5 and subsections.

1.2 The nomenclature of Superpave bituminous mixture names, e.g. SP125HCLP, is as follows. For convenience, sometimes only the aggregate size is shown, e.g. SP125. When that is the case, the specifications apply to all variations of that size, e.g. SP125HC, SP125MD, SP125HCLP, etc. Where "x" or "y" are indicated, e.g. SP125xyLP, specifications shall apply to all variations of corridor or mixture designs.

SP	Superpave
125.00	12.5 mm nominal aggregate size
190.00	19.0 mm nominal aggregate size
250.00	25.0 mm nominal aggregate size
x	Type of Corridor: H - heavy, M - medium, L - light duty
y	Mixture design: B, C, D, E, or F (as described below)
LP	Limestone porphyry (when designated)
SM	Stone Mastic Asphalt (when designated)

1.3 The following cumulative ESALs are utilized for the specified Superpave mixture design. A higher design traffic and same size aggregate mix design may be substituted at no cost to MoDOT for the contract specified mix design with the approval of the engineer, however substitution shall be done uniformly and project mixing of various designs for the same work will not be allowed. For example, an SP125HB mixture may be substituted for an SP125MC mixture, or SP190MC for SP190MD, etc. Mix design substitution shall be limited to one design level higher than that specified in the contract.

Design Traffic (ESALs)	Design
< 300,000	F
300,000 to < 3,000,000	E
3,000,000 to < 10,000,000	D
10,000,000 to < 30,000,000	C
>=30,000,000	B

2.0 Materials. All materials shall conform to Division 1000, Materials Details, unless otherwise noted.

2.1 Asphalt Binder. The asphalt binder shall be a Performance Graded material of the grade specified in the contract for the SP mixtures.

2.2 Aggregates. Aggregates shall meet the requirements of Sec 1002 for Type I-C when a SP125 mixture is specified and for Type I-B when a SP190 or SP250 mixture is specified except as herein modified.

2.2.1 Sec 1002.1.1.1, 1002.1.3.1, 1002.1.5 and 1002.1.8 shall not apply. Gradation requirements of Sec 1002.2.2 and 1002.2.3 shall not apply. However, gravel aggregates shall be washed sufficiently to remove any objectionable coating, and crushing of gravel aggregates will be required to meet the coarse or fine aggregate angularity specified herein.

2.2.2 Fine aggregates manufactured by the mechanical reduction of sound durable rock shall be manufactured from ledges which meet the same soundness requirements as for the coarse aggregate.

2.2.3 Blended Aggregate. The blended aggregate shall meet the grading for the specified SP mixture.

2.2.3.1 For SP125xyLP and SP125xySM mixtures, at least 50 percent by volume of the plus No. 8 (2.36 mm) material shall be from crushed porphyry as specified in Sec 1002. Depending on the actual gradation of porphyry aggregate furnished, the amount of crushed porphyry required will vary, however at least 40 percent by weight of crushed porphyry will be required.

2.2.3.1.1 Steel slag may be substituted for porphyry in SP125xySM mixtures but at least 45 percent by weight of crushed porphyry and/or slag will be required.

2.2.3.1.2 Surface Mixtures. Design level B mixtures containing limestone coarse aggregate shall contain a minimum amount of non-carbonate aggregate. Los Angeles (LA) abrasion values, AASHTO T 96, of the limestone will determine the type and amount of non-carbonate aggregate required as shown in the table below. The LA value will be determined from the most recent source approval sample. In lieu of the above requirements, the aggregate blend shall have an acid insoluble residue (A.I.R.), MoDOT T 76, meeting the plus No. 4 (4.75 mm) criteria of crushed non-carbonate material. Non-carbonate aggregate shall have an A.I.R. of at least 85 percent insoluble residue.

Coarse Aggregate (+ No. 4)	Minimum Non-Carbonate by Volume
Limestone, LA \leq 30	30% Plus No. 4 Sieve
Limestone, LA > 30	20% Minus No. 4 Sieve
Dolomite	No Requirement

2.2.3.2 Material Limitations.

2.2.3.2.1 Steel slag shall not exceed 30 percent by weight of the mineral aggregate retained on the 3/8 inch (9.5 mm) sieve or 20 percent by weight of the mineral aggregate passing the 3/8 inch (9.5 mm) sieve, except for SP125xySM mixtures.

2.2.3.2.2 Flint chat produced in the Joplin area shall not exceed 25 percent by weight of the

mineral aggregate.

2.2.3.2.3 Crushed gravel shall not exceed 20 percent by weight of the mineral aggregate.

2.2.3.3 Fine Aggregate Angularity. Fine aggregate angularity is measured on the fine portion of the blended aggregate. When tested in accordance with AASHTO T 304 Method A, aggregate particles passing the No. 8 (9.5 mm) sieve shall meet the following criteria for the minimum percent air voids in loosely compacted fine aggregate.

Design	Design Traffic (ESALs)	
F	< 300,000	--
E	300,000 to < 3,000,000	40
D	3,000,000 to < 10,000,000	45
C	10,000,000 to < 30,000,000	45
B	>=30,000,000	45

2.2.3.4 Coarse Aggregate Angularity. Coarse aggregate angularity is measured on the coarse portion of the blended aggregate. It is defined as the percent by weight of the aggregate particles larger than No. 4 (4.75 mm) sieve with one or more fractured faces. A fractured face is an angular, rough, or broken surface of an aggregate particle created by crushing or other artificial means. When tested in accordance with ASTM D 5821, "Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate", the coarse aggregate shall meet the following criteria. As shown, the criteria denotes the minimum allowable percentage of the coarse aggregate with "one / two" fractured faces, e.g. an "85/80" requirement means that the coarse aggregate shall have a minimum of 85 percent particles by weight with one fractured face and a minimum of 80 percent particles by weight with two fractured faces.

Design	Design Traffic (ESALs)	
F	< 300,000	55/-
E	300,000 to < 3,000,000	75/-
D	3,000,000 to < 10,000,000	85/80
C	10,000,000 to < 30,000,000	95/90
B	>=30,000,000	100/100

2.2.3.5 Clay Content. When tested in accordance with AASHTO T 176, blended aggregate particles passing the No. 4 (4.75 mm) sieve shall meet the following minimum sand equivalent criteria.

Design	Design Traffic (ESALs)	Sand Equivalent
F	< 300,000	40
E	300,000 to < 3,000,000	40
D	3,000,000 to < 10,000,000	45
C	10,000,000 to < 30,000,000	45
B	>=30,000,000	50

2.2.3.6 Thin, Elongated Particles. For all mixtures except SP125xySM, no more than 10 percent of the blended aggregate particles retained on the No. 4 (4.75 mm) sieve shall have a ratio of maximum to minimum dimensions greater than 5 when tested in accordance with ASTM D 4791.

2.2.4 Additional SP125xySM Requirements. In addition to other requirements, material for

SP125xySM mixtures shall meet the following:

2.2.4.1 Coarse aggregates shall consist of crushed limestone and either porphyry or steel slag, all meeting the quality requirements of Sec 1002 except as follows: The Los Angeles abrasion, when tested in accordance with AASHTO T96, shall not exceed 40 percent based on preliminary ledge approval and the final product. The amount of flat and elongated particles (measured on material retained on a No. 4 sieve (4.75 mm)) shall not exceed 20 percent based on a 3:1 ratio nor 5 percent based on a 5:1 ratio. The percent absorption, when tested in accordance with AASHTO T 85 shall not exceed 3.5 percent based on a final product. The limestone may be furnished in one fraction and shall generally pass the 1/2 inch (12.5 mm) sieve and shall have a minimal amount passing the No. 4 (4.75 mm) sieve. Porphyry or steel slag shall be furnished in two or more fractions.

2.2.4.2 Portland cement shall not be used as mineral filler.

2.2.4.3 A fiber additive meeting Sec 1071 shall be utilized as a stabilizer. Fibers provided in loose form shall be in plastic bags suitable for dissolving in the mixture or fibers may be mechanically blown into the plant. Pelletized fibers may be approved provided the fibers can be uniformly distributed by the end of the plant mixing process and provided any additive used to form the pellets does not affect the final product. The dosage rate for fibers shall be not less than 0.3 percent by mass of the total mix for cellulose and not less than 0.4 percent by mass for mineral fibers.

3.0 Composition of Mixtures.

3.1 Prior to mixing with asphalt binder, the combined aggregate gradation, including filler if needed, shall meet the following gradation for the type of mixture specified in the contract.

Sieve Size	Percent Passing by Weight			
	SP250 (1 in. Nom. Max. Size)	SP190 (3/4 in. Nom. Max. Size)	SP125 (1/2 in. Nom. Max. Size)	SP125xySM (1/2 in. Nom. Max. Size)
1 1/2 in. (37.55 mm)	100.00	---	---	---
1 in. (25.0 mm)	90 - 100	100.00	---	---
3/4 in. (19.00 mm)	90 max.	90 - 100	100.00	100.00
1/2 in. (12.5 mm)	---	90 max.	90 - 100	85 - 95
3/8 in. (9.5 mm)	---	---	90 max.	75 Max.
No. 4 (4.75 mm)	---	---	---	20 - 28
No. 8 (2.36 mm)	19 - 45	23 - 49	28 - 58	16 - 24
No. 16 (1.18 mm)	---	---	---	---
No. 30 (600 µm)	---	---	---	12 - 16
No. 50 (300 µm)	---	---	---	12 - 15
No. 100 (150 µm)	---	---	---	---
No. 200 (75 µm)	1 - 7	2 - 8	2 - 10	8 - 10

3.1.1 The combined aggregate gradation shall not pass through the restricted zone as shown in the table below and as plotted on a 0.45 power chart.

Aggregate Restricted Zone

<u>Sieve Size</u>	<u>SP250</u>	<u>SP190</u>	<u>SP125</u>
No. 4 (4.75 mm)	39.50	---	---
No. 8 (2.36 mm)	26.8 - 30.8	34.6	39.1
No. 16 (1.18 mm)	18.1 - 24.1	22.3 - 28.3	25.6 - 31.6
No. 30 (600 μ m)	13.6 - 17.6	16.7 - 20.7	19.1 - 23.1
No. 50 (300 μ m)	11.4	13.7	15.5

3.1.2 A job mix formula may be approved which permits the combined aggregate gradation to be outside the limits of the master range when the full tolerances specified herein are applied.

3.1.3 All mixtures, except SP125xySM, shall contain a minimum of one percent hydrated lime in accordance with Sec 403.5(e).

3.1.3.1 In lieu of hydrated lime, a liquid anti-strip may be allowed by the engineer. Liquid anti-strip agents and application rates shall be from a list approved by the Materials Engineering.

4.0 Job Mix Formulas.

4.1 General. The contractor shall provide the job mix formula for each mixture. A detailed description of the mix design process shall be included with job mix formula. Representative samples of asphalt binder and mineral aggregates shall be submitted to the Central Laboratory for mixture verification. At least 30 days prior to the contractor preparing any of the mixture on the project, the engineer shall have received both the representative samples of the job mix materials and the contractor's proposed job mix formula.

4.1.1 The mix design shall contain the following information:

- (a) Source, grade and specific gravity of asphalt binder.
- (b) Source, type (formation, etc.), ledge number if applicable, and gradation of the aggregates.
- (c) Bulk and apparent specific gravities and absorption of each aggregate fraction in accordance with AASHTO T 85 for coarse aggregates and AASHTO T 84 for fine aggregates.
- (d) Specific gravity of hydrated lime or mineral filler, if used, in accordance with AASHTO T 100.
- (e) Percentage of each aggregate component.
- (f) Combined gradation of the job mixture.
- (g) Percent asphalt binder, by weight, based on the total mix.
- (h) Bulk specific gravity (G_{mb}) by AASHTO T 166 Method A of a laboratory compacted mixture compacted N_{design} gyrations .

- (i) Percent air voids (V_a) of the laboratory compacted specimen compacted to N_{design} gyrations .
- (j) Voids in the mineral aggregate (VMA) and voids in the mineral aggregate filled with asphalt binder (VFA) at N_{design} gyrations.
- (k) Theoretical maximum specific gravity (G_{mm}) as determined by AASHTO T 209 after the sample has been short term aged in accordance with AASHTO TP4.
- (l) The tensile strength ratio as determined by AASHTO T 283, including all raw data.
- (m) The gyratory sample weight to produce a 115 mm minimum height specimen.
- (n) Mixing temperature and gyratory molding temperature.
- (o) Number of gyrations at $N_{initial}$, N_{design} , and $N_{maximum}$.
- (p) Dust proportion ratio ($-200/P_{be}$).
- (q) Bulk specific gravity (G_{sb}) of the combined aggregate.
- (r) Percent chert contained in each aggregate fraction.
- (s) Percent of Gmm at $N_{initial}$ and $N_{maximum}$.
- (t) Blended aggregate properties for clay content, angularity, and thin and elongated particles.

4.1.2 No mixture will be accepted for use until the job mix formula for the project is approved by the engineer.

4.1.3 The job mix formula shall be within the master range specified for the particular type of asphaltic concrete, and shall include the type and sources of all materials, the gradations of the aggregates, the relative quantity of each ingredient, and shall state a definite percentage for each sieve fraction of aggregate and for asphalt binder.

4.1.4 The job mix formula approved for each mixture shall be in effect until modified in writing by the engineer. When unsatisfactory results or other conditions occur, or should a source of material be changed, a new job mix formula may be required.

4.2 Mixture Testing Procedures.

4.2.1 SP bituminous mixtures shall be tested in accordance with AASHTO Provisional Standard TP 4, Standard Method for Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of SHRP Gyratory Compactor, except as herein noted.

4.2.2 SP mix design shall follow the procedures defined in AASHTO PP 28.

4.2.3 The contractor is advised that SP mix design will require gradation design, asphalt binder content design, moisture susceptibility testing, and nuclear gauge or ignition oven calibration. It may also require testing of the blended aggregate once the mixture design is completed. For Quality Acceptance purposes, MoDOT will perform the nuclear gauge and binder ignition calibration at the time of the mixture verification.

4.3 Compaction Criteria.

4.3.1 The number (N) of gyrations required for gyratory compaction shall be as follows:

Design	Design Traffic (ESALs)	N _{initial}	*N _{design}	*N _{maximum}
F	< 300,000	6	50	75
E	300,000 to 3,000,000	7	75	115
D	3,000,000 to < 10,000,000	8	100	160
C	10,000,000 to < 30,000,000	8	100	160
B	>= 30,000,000	9	125	205

* SP125xySM mixtures shall have N_{design} equal to 100 and no N_{maximum} requirement.

In addition, the compaction level, as a percent of theoretical maximum specific gravity, shall be less than or equal to 91.5 percent for Design F, 90.5 percent for Design E and 89.0 percent for Designs D, C, and B at N_{initial}, equal to 96.0 percent at N_{design} and should be less than or equal to 98.0 percent at N_{maximum}.

4.3.2 When compacted in accordance with AASHTO Provisional Standard TP 4 the mixture shall meet the following criteria.

4.3.2.1 Air Voids (V_a).

Design Traffic (ESALs)	Design Air Voids (percent)
All Levels	4.0

4.3.2.2 Voids in the Mineral Aggregate (VMA).

Mixture	VMA Minimum (percent)
SP250	12.0
SP190	13.0
SP125 (except for below)	14.0
SP125xySM	17.0

4.3.2.3 Voids Filled With Asphalt (VFA).

Design	Design Traffic (ESALs)	VFA (percent)*
F	< 300,000	70 - 80
E	300,000 to < 3,000,000	65 - 75
D	3,000,000 to < 10,000,000	65 - 75
C	10,000,000 to < 30,000,000	65 - 75
B	>=30,000,000	65 - 75

*SP125xySM mixtures shall have a minimum VFA of 75 percent.

4.4 Other Criteria.

4.4.1 For all mixtures except SP125xySM, the ratio of minus No. 200 material to effective asphalt binder (P_{be}) shall be between 0.6 and 1.2 for mixtures above the restricted zone boundary and 0.8 to 1.6 for mixtures below the restricted zone boundary.

4.4.2 For all mixtures except SP125xySM, the mixture shall have a tensile strength ratio (TSR) greater than 80 percent when compacted to 95 mm with 7 ± 1 percent air voids and tested in accordance with AASHTO T 283, as modified below. SP125xySM mixtures shall have a TSR greater than 80 percent when compacted to 95 mm with 6 ± 1 percent air voids and tested in accordance with AASHTO T 283, as modified below.

4.4.2.1 Modify the procedures in the following Sections of AASHTO T-223 as noted.

- a. Section 4.1 One freeze cycle will be required.
- b. Section 5.1 Include AASHTO TP4 as an alternative compaction method.
- c. Section 6.2 Specimens 150mm (6 in.) in diameter and 95 mm (3.75 in.) thick are used.
- d. Section 6.5 After curing, place the mixture in an oven set at the appropriate compaction temperature and age the material for 2 hours prior to compaction. The mixture shall be compacted to 7.0 ± 0.5 percent air voids, except SMA mixtures shall be compacted to 6.0 ± 0.5 percent air voids.
- e. Section 6.6 A minimum of 72 hours storage is required before evaluation of the specimens in accordance with Section 8.
- f. Section 9.3.2 Prior to placing the specimen in the vacuum vessel, place a sheet of plastic film on the balance and zero the balance. The plastic film is to ensure any water draining from the specimen is not lost. Within 2 minutes of removing the sample from the vacuum vessel, determine SSD mass of the specimen.
- g. Section 9.3.3 Calculate the degree of saturation and determine if the degree of saturation is acceptable. Acceptable degree of saturation shall be between 55 percent and 65 percent as determined by comparing SSD mass to the vacuum SSD mass of the specimen.
- h. Section 9.3.4.2 If the degree of saturation is acceptable, wrap the specimen with the plastic film and place in a plastic bag containing 10 mL of water. Within 2 minutes of placing the specimen in the bag, the specimens shall be placed in the freezer. All moisture draining from the specimen during the process is to be collected by the plastic film and is not permitted to be discarded.

4.4.3 AASHTO T 305, draindown test, shall be performed on all SP125xySM mixtures prior to job mix approval. The mixture shall be stabilized in such a way that the draindown of the asphalt binder shall not exceed 0.3 percent by weight of mix.

4.4.4 The percent VCA_{MIX} of SP125xySM mixtures shall be less than or equal to the VCA_{DRC} as determined using AASHTO T19. This can be calculated using the following equations:

$$VCA_{DRC} = 100 \times (G_{CA}\gamma_W - \gamma_s) / G_{CA}\gamma_W$$

$$VCA_{MIX} = 100 - (P_{bp} \times G_{mb} / G_{CA})$$

$$P_{bp} = P_s \times PA_{bp}$$

where,

- G_{CA} - bulk specific gravity of the combined coarse aggregate (T 85),
- γ_s - unit weight of coarse aggregate in the dry-rodded condition (lb./ft³) (Kg/m³)(T 19),
- γ_W - unit weight of water (62.34 lb./ft³) (1000 Kg/m³),
- P_{bp} - percent aggregate by total mixture weight retained on #4 (4.75 mm) sieve and
- PA_{bp} - percent aggregate by total aggregate weight retained on # 4 (4.75 mm) sieve.

4.4.5 The percent asphalt binder for SP125xySM mixtures shall not be less than 6.0 percent unless otherwise allowed by the engineer.

4.5 If difficulty is experienced in obtaining a satisfactory mixture with the aggregate combinations submitted, the contractor will be advised and new types or sources of materials may be required by the engineer. Note that additional aggregate other than local stone or sand may be required in order to modify the mixture for compliance.

5.0 Construction. For the purposes of placement, SP250 and SP190 shall be treated like Type I B mixture, SP125 like Type I-C mixture and SP125xySM like SMA mixture, except that the compacted thickness for SP125 shall be between 1.5 and 2.25 inches (35 and 60mm), the compacted thickness for SP190 shall be between 2 and 3 inches (50 and 75mm), and the compacted thickness for SP250 shall be between 3 and 4.5 inches (75 and 115mm).

5.1 Weather Limitations.

5.1.1 SP190 and SP125 mixtures shall be placed in accordance with the weather limitations of Sec 403, except that SP125xySM mixtures shall not be placed when either the air temperature or the temperature of the surface on which the mixture is to be placed is below 60 °F .

5.1.2 SP250 mixtures shall be placed in accordance with the following weather limitations. SP250 mixtures shall not be placed (1) when either the air temperature or temperature of the surface on which the mixture is to be placed is below 40 °F, (2) on any wet or frozen surface, or (3) when weather conditions prevent the proper handling or finishing of the mixture. Temperatures are to be obtained in accordance with [MoDOT Test Method T20](#).

5.2 Gradation Control.

as follows:

5.6.1 Full production shall not start until an acceptable test strip meeting density, gradation, percent asphalt binder, and one-half the specification tolerances for the volumetric requirements of the contract have been obtained.

5.6.2 A mix which has been field adjusted in accordance with [MSP-96-01, Section 10.0](#), will not require a new test strip.

5.6.3 Test strips which do not meet specification requirements for density, air void and voids in the mineral aggregate shall be removed.

5.6.4 No payment will be made for test strips required as a result of a contractor initiated change in job mix formula, compaction method, compaction equipment, or if unacceptable results occur as determined by the engineer.

6.0 Payment. Payment for the above described work including all materials, equipment, labor, and any other incidental work necessary to complete this item shall be considered as completely covered by the unit prices as set out in this proposal. SMA fibers are paid for separately at the contract unit price. The accepted quantities of Superpave mixtures will be paid for at the contract unit price for mixture specified, SP125xy, SP125xyLP, SP125xySM, SP190xy, or SP250xy, where "x" and "y" are specifically identified in accordance with this specification. Pay adjustments described in Section 403.18.5 for SMA shall not apply.